Design and Implementation of Novel Methods for Predicting Stock Market Trends

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Abstract

Stock price forecasting is a popular and important topic in financial and academic studies. Predicting the Stock Market is quite challenging, and it requires intensive study of the pattern of data. Specific statistical models and artificially intelligent algorithms are needed to meet this challenge and arrive at an appropriate solution. Various machine learning and deep learning algorithms can make a firm prediction with minimized error possibilities. The Neural Network (NN) model that have been extensively used to predict the stock market prices. The models have been used to predict upcoming days' data values from the last few days' data values. This process keeps on repeating recursively as long as the dataset is valid. Many methods like technical analysis, fundamental analysis, time series analysis and statistical analysis, etc. are all used to predict the price in the stock market but none of these methods are proved as a consistently acceptable prediction tool. Hence there is more scope to improve the prediction methods with a different optimizer. This research study is focused on developing neural network model to precdict the stock market trends precisely.

1 Introduction

Stock Market prediction and analysis is the act of trying to determine the future value of a company stock or other financial instrument traded on an exchange. Stock market is the important part of economy of the country and plays a vital role in the growth of the industry and commerce of the country that eventually affects the economy of the country. Both investors and industry are involved in stock market and wants to know whether some stock will rise or fall over certain period of time.As the technology is increasing, stock traders are moving towards to use Intelligent Trading Systems rather than fundamental analysis for predicting prices of stocks, which helps them to take immediate investment decisions. One of the main aims of a trader is to predict the stock price such that we can sell it before its value decline, or buy the stock before the price rises. The efficient market hypothesis states that it is not possible to predict stock prices and that stock behaves in the random walk. It seems to be very difficult to replace the professionalism of an experienced trader for predicting the stock price

Following figure illustrate the basic functioning of stock market prediction.

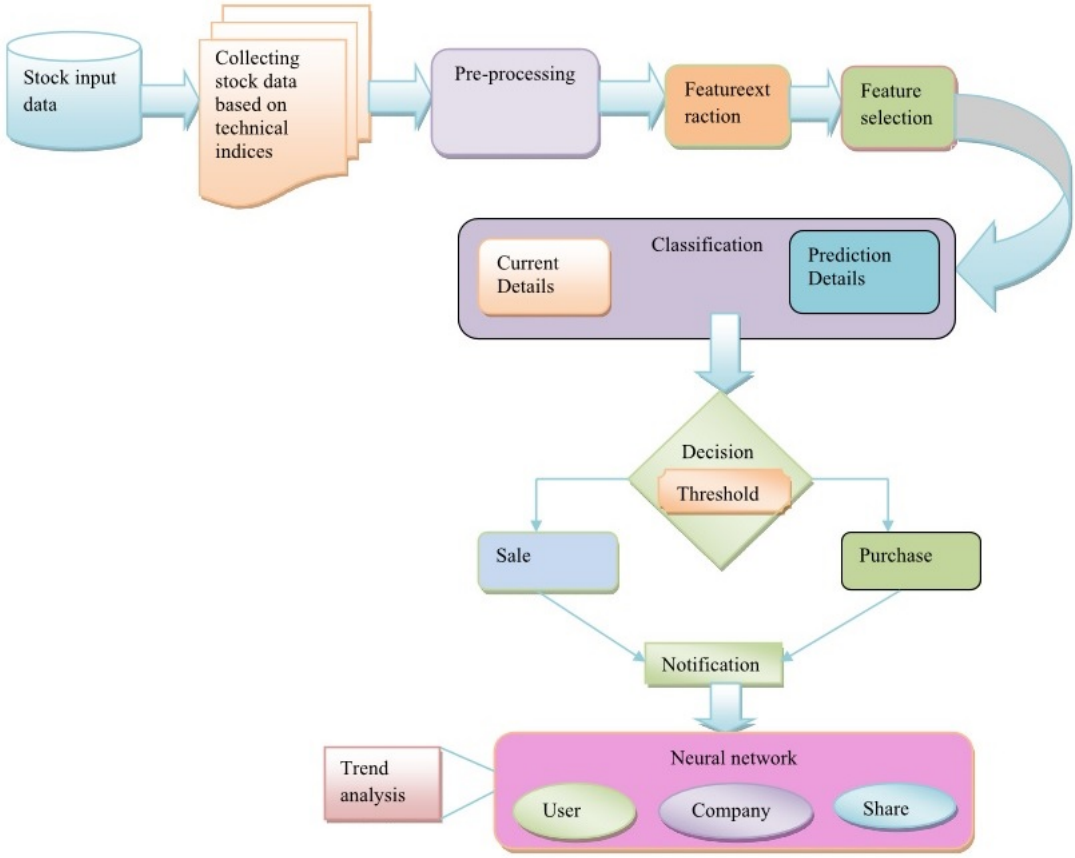

Figure 1: Block diagram of the functioning of the stock market prediction system [14]

The stock market is the primary source for any company to raise funds for business expansions. It is based on the concept of demand and supply. If the demand for a company's stock is higher, then the company share price increases and if the demand for company's stock is low then the company share price decrease. Another motivation for research in this field is that it possesses many theoretical and experimental challenges. The most important of these is the Efficient Market Hypothesis (EMH), the hypothesis says that in an efficient market, stock market prices fully reflect available information about the market. One of the example of big exchange is New York Stock Exchange. Various types of analysis can be performed on input data.

1.1 Sentiment analysis

Sentiment analysis uses text mining, natural language processing, and computational techniques to automatically extract sentiments from a text. It aims to classify the polarity of a given text at the sentence level or class level, whether it reflects a positive, negative, or neutral view. In stock market prediction task, two important sources of the text are used either social media mainly using Twitter data or online financial news article.

1.1.1 Twitter sentiment

Twitter is a significant source of data, and many researchers have examined its relationship with stock market movements. While each tweet is restricted to 140 characters, it is believed that the information can accurately reflect public mood.

1.1.2 Online financial news sentiment

Financial news articles are perceived to be a more consistent and reliable source of information. Many researchers suggested that the financial news articles have a strong relationship with stock market fluctuation; therefore, analyzing financial news reports can help in predicting the stock market movements.

1.2 Textual data preprocessing

Textual data need to be prepared before used by the machine learning algorithm for sentiment analysis task using following methods.

1.3 Feature extraction

Feature extraction or sometimes called attribute selection aim to select features, attributes, or piece of text that is more relevant to the prediction task. Many methods have been used for feature selection. The commonly used feature selection procedure for

document or sentence classification task is the bag-of-words (BOW) approach, which was recently used for market prediction by many authors. In the BOW model, each word in a text or document will be treated as a feature neglecting the grammar or word order and only preserving the abundance. The second most popular method used recently for the feature selection process is Word2vec. In this technique, the aim is to learn word embedding using a two-layer neural network. The input to that neural network is a text, and the output is a group of vectors (i.e. the input is a corpus and the output is a vector of words).

Another important feature selection method is the latent Dirichlet allocation (LDA) technique used recently for market prediction in. In the LDA model, the text is viewed as probabilistic collections of terms or words, and the collections are then treated as selected features. Other researches used a Skip-Gram model that aims to predict the context word (surrounding words) for a given target word. However, feature selection is a crucial step in the textual data preprocessing, and many other strategies may also be used for text analysis.

1.4 Feature representation

After feature selection, every feature must be illustrated by a numeric value so that it can be analyzed by machine learning techniques. The most common technique of feature representation is a binary representation (BR), which is a number system that uses two values such as 0 and 1 exclusively to represent the information. This technique has been exploited for market prediction researches by many authors. The second most popular method used in text mining for financial application is the term frequency-inverse document frequency (TF-IDF), which is a numeric value that represents the significance of a word for a document or corpus that is used recently by many authors. Other feature representation methods can also be used successfully in text preprocessing, and we will discuss those with more details in the following sections.

2 Literature Survey

In the last few decades forecasting of stock returns has become an important field of research. In most of the cases the researchers had attempted to establish a linear relationship between the input macroeconomic variables and the stock returns. After the discovery of nonlinearity in the stock market index returns, many literatures have come up in nonlinear statistical modeling of the stock returns. most of them required that the nonlinear model be specified before the estimation is done. But stock market return is noisy, uncertain, chaotic and nonlinear in nature. Hence ANN and DL algorithms has evolved out to be better technique in capturing the structural relationship between a stock's performance

and its determinant factors more accurately than many other statistical techniques.

In this literature survey, different sets of input variables are used to predict stock returns. In fact, different input variables are used to predict the same set of stock return data. Some researchers used input data from a single time series where others considered the inclusion of heterogeneous market information and macro-economic variables.

- Jiang, Weiwei [1], presented a latest review of recent works on deep learning models for stock market prediction. In this paper, they have used many parameters to compare recent progress like raw input data type, distribution of data length, etc. They have presented the review of 100+ related published articles in the past three years. This paper also gives the special attention to the implementation of Deep Learning models and the reproducibility of published articles. They have summarized the publications in both theoretical and practical aspects.

- Lee, Jinho, et al. [2], they have applied Deep Q-Network with a Convolutional Neural Network function approximator, which takes stock chart images as input for making global stock market predictions. The proposed model not only yields profit in the stock market of the country whose data was used for training their model but also generally yields profit in global stock markets. They have trained the proposed model only on US stock market data and tested it on the stock market data of 31 different countries over 12 years. The results show that some patterns in stock chart images indicate the same stock price movements across global stock markets. Moreover, the results show that future stock prices can be predicted even if the model is trained and tested on data from different countries. The model can be trained on the data of relatively large and liquid markets (e.g., US) and tested on the data of small markets. It means that if the model structure, input feature, and training procedure are satisfactory, the model does not have to be trained and tested in the same market.

- Naik, Nagaraj, and Biju R. Mohan [3], proposed a stock crisis prediction model. Stock crisis prediction is a difficult task due to more volatility in the stock market. Stock price sell-offs are due to various reasons such as company earnings, geopolitical tension, Financial crisis, and pandemic situations. Hence, stock crisis prediction is a challenging task. In this paper, the proposed model works in five steps. They have used Hybrid Feature Selection (HFS) technique to select features, Naive Bayes method is considered to classify the strong fundamental stock, Extreme Gradient Boosting (XGBoost) and Deep Neural Network (DNN) regression method for stock crisis prediction based. They have considered considered the Indian datasets for experimentation.

- Mukherjee, Somenath, et al [4], this study proposes two approaches to predict stock

market indices and stock prices. This study first uses a Feed-forward Neural Network and performs the backpropagation algorithm for the training process. This model gave a fundamental insight into the prediction trend. So, to overcome the cost of extensive training, this study gives another cleaner approach. The Convolution Neural Network model proved to give better results on a given dataset. In this study, they have got a different approach to analyze timeseries data. It utilizes greyscale 2-D histograms generated from time-series data for prediction. The entire dataset is broken down into 15 segments, every segment is fed into the CNN model, and maximum accuracy is obtained for each of them. This increase in input to the model makes a vast difference in the training time and prediction accuracy.

- Chen, Shile, and Changjun Zhou [5], have proposed the approach which makes the use Genetic Algorithm (GA) for feature selection and develop an optimized Long Short-Term Memory(LSTM) neural network stock prediction model. Firstly, they have used the GA to obtain a factors importance ranking. Then, the optimal combination of factors is obtained from this ranking with the method of trial and error. Finally, they have used the combination of optimal factors and LSTM model for stock prediction. For this study, they have used the China construction bank dataset and the CSI 300 stock dataset demonstrate that the GA-LSTM model can outperform all baseline models for time series prediction.

- Wang, Li-Xin [6] have proposed a deep convolutional fuzzy system (DCFS) model and training algorithms. This model gives the best performance means it is very fast, highly interpretable and flexible. It supports online learning. It provides a natural structure for parallel computing and it is suitable for the high-dimensional problems.

- Bouktif, Salah, Ali Fiaz, and Mamoun Awad [7] presented a model which utilized Twitter data as our information corpus to predict ups and downs of six well known NASDAQ companies. They have also proposed proposed a methodology that starts by extracting multiple text-based features to enrich the representation of sentiments. Then it applies diverse feature selection methods to contextually choose the appropriate feature sets for different circumstances and ends by stacking individual models to get the best of base stock direction classifiers.

- Kilimci, Zeynep Hilal, and Ramazan Duvar [9] have proposed a word embedding and deep learning-based direction prediction of Istanbul Stock Exchange (BIST 100). In this technique, the proposed model makes the use of data by analyzing nine banking stocks with high volume in BIST 100. Experiment results demonstrate that the combination of deep learning techniques and word embedding methods have a great potential to predict the direction of BIST 100.

- Nabipour, Mojtaba, et al. [10] presented a study which aims to significantly reduce the risk of trend prediction with machine learning and deep learning algorithms. They have considered continuous and binary data as an input. The experimental results of this study showed that there was a significant improvement in the performance of models when they use binary data instead of continuous one. RNN and LSTM algorithms are used in both the approaches.

- Rather, Akhter Mohiuddin [13], proposed a new method of predicting time-series-based stock prices and a new model of an investment portfolio based on predictions obtained. A new regression scheme is implemented on a long-short term-memory-based deep neural network to obtain predictions. This proposed model outperforms various standard predictive models as well as various standard portfolio optimization models.

- In this paperLi, Yang, and Yi Pan [16] have proposed a novel deep learning architecture to predict stock prices by combining multiple recurrent neural networks to form a blending ensemble learning model. The blending ensemble model captures the changes in time series influence on the stock price. To evaluate the effectiveness of the method, we have conducted experiments on different recurrent neural network models and set up the same environment and configures to compare with the blending ensemble model.

- Bag, Vipul, and Uday V. Kulkarni [23] presented a model which emphasizes on stock price trend prediction based on the online textual news. Cognitive process uses existing knowledge and generates new knowledge. Contextual features (CF), from news sites are extracted and recommendations based on the interpretations are generated. A Naïve bays classification algorithm is used to classify the news sentiments. A News Sentiment Index (NSI) is calculated and effect of the news on particular stock is calculated to predict the trend.

- Song, Yoojeong, Jae Won Lee, and Jongwoo Lee [24] presented a study which intends to learn fluctuation of stock prices in stock market by using recently spotlighted techniques of deep learning to predict future stock price. In previous studies, we have used price-based input-features to measure performance changes in deep learning models. Results of this studies have revealed that the performance of stock price models would change according to varied input-features configured based on stock price.

- In this study [22], stock value prediction has been made for the three sport clubs Galatasaray (GSRAY), Fenerbahçe (FENER) and Beşiktaş (BJKAS) that have stock values in Borsa Istanbul. Sentiment analysis results that have been obtained

using the Public Disclosure Platform notification data about GSRAY, FENER and BJKAS have been used in addition to financial data that belong to these companies for stock market prediction. Long-short term memory, which is one of the deep learning methods, has been used for prediction. According to experimental results, when Public Disclosure Platform notification data about these companies have been used in prediction, the prediction results are more accurate.

- Portfolio optimization is a hot research topic, which has attracted many researchers in recent decades. Better portfolio optimization model can help investors earn more stable profits. This paper [20] have used three deep neural networks (DNNs), i.e., deep multilayer perceptron (DMLP), long short memory (LSTM) neural network and convolutional neural network (CNN) to build prediction-based portfolio optimization models which own the advantages of both deep learning technology and modern portfolio theory. These models first use DNNs to predict each stock's future return. Then, predictive errors of DNNs are applied to measure the risk of each stock. Next, the portfolio optimization models are built by integrating the predictive returns and semi-absolute deviation of predictive errors. These models are compared with three equal weighted portfolios, where their stocks are selected by DMLP, LSTM neural network and CNN respectively. Also, two prediction-based portfolio models built with support vector regression are used as benchmarks.

- Stock movement prediction using Tweets (text) and historical price signals (time series) remains a challenging task due to the complex, noisy and dynamic nature of the stock market. The key to improve prediction performance is effectively capturing the complementarity between market sentiment signal from Tweets and time-series signal from the stock price. In this paper [26], they have proposed a new solution to StockNF by exploiting a deep generative model technique, Normalizing Flow (NF), to learn more flexible and expressive posterior distributions of latent variables of Tweets and price signals, which can largely ameliorate the bias inference problem in existing methods. They have evaluated the NF technique on a public stock movement prediction dataset and show that StockNF outperforms the state-of-the-art baselines.

- Vargas, Manuel R., Beatriz SLP De Lima, and Alexandre G. Evsukoff [30] have proposed a model to predict the intraday stock market directional movements of the S and P index using financial news title and financial time series market data as input. The paper compared two commonly used deep learning methods, which are RNN and CNN algorithms using many text representation methods. The RNN method used in the paper was the LSTM model. The proposed model examined many types of text representation as an input to the CNN prediction model. The

results prove that the sentence embedding for text representation is more effective than the word embedding.

- Many researchers believe that analyzing only the historical prices of the stock market will be able to predict the stock market movement [10, 16, 18]. However, other researchers combine both textual information with historical prices of stock to predict the stock market movements [15]. The previous studies' major limitation is that they depend heavily on either structured data (historical stock prices) or unstructured data (news articles or social media). However, for the researchers that used both structured and unstructured data, the major limitation for most of them is that they combined either news articles or social media with past stock prices to predict the stock movements and they neglect the critical impact of combining social media and financial news information's with time series market data to improve the forecasting results [15].

In general, many techniques will be able to improve the prediction methods such as adding the structural information to the prediction model, expanding the training period, using more effective expanded lexicons.

3 Objectives

Quite clearly, the problem we are looking to approach is stock market prediction. A successful and accurate prediction to the future stock prices ultimately results in profit maximization. We are trying to develop a model that will be capable of providing a market view. It would help to have better understanding of the stock markets. Here, we will be also focusing on finding quality data and processing the data also.

The main objective of the resesrch is to-

- Design a Deep Learning Model which predicts the stock crisis and stock price prediction accuratly.
- Identify Factors affecting to stock market.
- Predict an approximate value of share/stock price.
- Provide a model which will work with maximum accuracy and it should consider all important factors thet could influence the result.

4 Methodology

After thorough study of currently proposed methods and their implementation, new research direction will be determined. This involves designing new strategies to extract

different features from input data and identify the proper type of input data. Then, these features will be used to classify the datasets with proposed classifiers. Results will be compared to best contemporary methods which will give more insight and useful directions for further progress of research work.

5 Data Collection Procedure

The hardest part about building machine learning and AI based systems for trading isn't in model selection or implementation, it's in collecting quality data and identifying relevant features.Finding appropriate data and pre-processing that data is arguably the most important part of all modern machine learning problems. In an age of unlimited libraries, APIs, and guides for how to build and implement optimal models, the actual data is overlooked.

Here are some useful data resources: Favorites: https://db.nomics.world/ This resource is especially helpful. It's a compilation of massive amounts of economics datasets from all over the world.Download all datasets with one click
https://github.com/addisonlynch/iexfinance
Census Data: https://www.census.gov/data.html
Useful Collection of Forecasts: http://www.forecasts.org/stpoor.htm
Massive Collection of Indicators: https://www.assetmacro.com/
Labor Statistics: https://www.bls.gov/
Data from the US Treasury: https://home.treasury.gov/

6 Importanceof Study/Social Application

6.1 National and International status

The world has seen a drastic change since the outbreak of covid- 19 in late 2019 and early 2020. This resulted in a direct or indirect impact on every sector. Stock markets around the world saw a huge downfall within very little time. Some investors found this an opportunity to invest in equity-based investments, stocks, or mutual funds as it would fetch more units at a lesser price which could be sold later on at a higher price. The impact of the covid-19 pandemic on stock markets resulted in a change in the patterns of stock prices which no model had predicted before. The area of predictive analytics has progressed a lot and many developments take place each passing day.

6.2 Significance of the study

The stock market gives opportunities to businesses and the public to transfer capital and ownership in a controlled, secure and managed environment. In addition to this, it also provides a convenient way for companies to raise capital and for individuals to increase wealth, the stock market helps keep a check on corporate regulation and increases the economic growth and prosperity of the nation.

7 Proposed Plan

Year	Plan
1	Literature survey and basic implementation
2	Development of new algorithms, their implementation and result formulation
3	Paper writing and publishing
4	Thesis writing

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